NUTRITIONAL NEEDS OF VITAMIN D, VITAMIN E, FOLIC ACID AND FIBRE IN ELDERLY POPULATION

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ABSTRACT

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ABSTRACT

The nutritional status of elderly people living in Finland varies significantly. A good nutritional status is an important factor in the quality of life and healthy aging. The aim of this Bachelor's thesis was to review the nutritional status of elderly people in Finland in different types of accommodations concentrating on vitamin D, vitamin E, folic acid and fibre and find nutritious food materials for food product development for the elderly.

The thesis is linked to the EU-project "Optimised food products for elderly populations" (Optifel) which started in September 2013. The aim of the project is to improve the nutrition of the elderly by increasing the knowledge of the nutritional needs of the elderly and the needs and wishes for the foods targeted to them. The thesis was commissioned by MTT Agrifood Research Finland together with HAMK University of Applied Sciences.

The information on the nutritional status of elderly people living in Finland was based on Finnish studies and publications. Five different food composition databases were used to find nutritious food materials for product development. The information collected from the databases was compared with each other.

The results of the study showed that the nutritional status of elderly people living in Finland varies significantly. Factors associated with malnutrition were mostly the physiological and cognitive impairment of the malnourished person. However, sometimes malnutrition results from the actions of care givers. According to the Finnish food composition database, the most valuable foods for product development were nuts, dried fruits and egg yolk. They were good or moderate sources for most of the desired nutrients. The knowledge of the potential food materials for product development can be utilized later in the Optifel-project, when selecting nutritious ingredients for product development.

Keywords nutrition, elderly people, food composition database

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TIIVISTELMÄ

Suomessa iäkkäiden ihmisten ravitsemustilat vaihtelevat merkittävästi. Hyvä ravitsemus on tärkeä elämän laadun ja terveen vanhenemisen kannalta. Opinnäytetyön tavoitteena oli tarkastella suomalaisten vanhusten ravitsemustilaa eri asumusmuodoissa ja tarkastella D-vitamiini, E-vitamiinin, foolihapon ja kuidun merkitystä ravitsemuksessa sekä etsiä ravinteikkaita raaka-aineita vanhuksille kohdistettujen elintarvikkeiden tuotekehitykseen.

Opinnäytetyö liittyi syyskuussa 2013 alkaneeseen EU-hankkeeseen ”Optimised food products for elderly populations” (Optifel). Hankkeen tavoitteena on parantaa ikääntyneiden ravitsemusta lisäämällä tietoisuutta ikääntyneiden ravitsemuksellisista tarpeista, vaatimuksista ja toiveista heille suunniteltavien elintarvikkeiden osalta. Opinnäytetyön toimeksiantaja oli Maa- ja elintarviketalouden tutkimuskeskus (MTT) yhteistyössä Hämeen ammattikorkeakoulun (HAMK) kanssa.

Vanhusten ravitsemustilaa Suomessa tarkasteltiin suomalaisten tutkimusten ja julkaisujen pohjalta. Ravinteikkaiden raaka-aineiden hakuun käytettiin viittä eri elintarvikkeiden koostumustietopankkia, joista saatuja tietoja verrattiin toisiinsa.

Vanhusten ravitsemuksellisen tilan tarkasteluosuudesta selvisi, että ravitsemustilat vaihtelevat huomattavasti Suomessa. Vajaaravitsemukseen yhdistetyt tekijät liittyivät lähinnä fysiologisten ja kognitiivisten toimintojen heikkenemiseen, mutta myös hoitohenkilöiden toiminnalla on vaikutusta.

Suomen elintarvikekoostumus tietopankin mukaan hyödyllisimmät raaka-aineet elintarvikkeiden tuotekehitykseen olivat pähkinät, kuivatut hedelmät ja kananmunan keltuainen. Ne olivat hyviä tai keskinkertaisia lähteitä suurimmalle osalle toivotuista ravintoaineista. Tietoa ravinteikkaista raaka-aineista voidaan hyödyntää myöhemmin Optifel-hankkeessa valittaessa raaka-aineita vanhuksille suunnattujen elintarvikkeiden kehitykseen.

Avainsanat ravitsemus, ikääntyneet, elintarvikekoostumus tietopankki

Sivut **33** s.

CONTENTS

1 INTRODUCTION

Aging causes many physiological changes that need to be taken into consideration when planning nutritional guidelines for elderly people. The most important change is decreasing of energy consumption. The energy consumption decreases mostly because of the loss of muscle mass and reduction of physical activity. Even though the energy consumption decreases, it does not make a difference in the need for nutrients. This means that the food eaten has to be rich in nutrients. A good nutritional status is important when recovering from illnesses and maintaining a high quality of life. (The National Nutrition Council 2010, 12.) For these reasons offering of nutritious and healthy food products for the elderly is very important.

There are significant differences in nutritional statuses between elderly people (>65 years old) living in different types of accommodations in Finland. Elderly people living at home independently are suffering from malnutrition much less than those who are hospitalized. (The National Nutrition Council 2010, 19.) According to Suominen (2007, 44), malnutrition in elderly patients in Finnish nursing homes is recognized poorly and therefore patients are not receiving nutritional treatment. Inadequate intake of vitamin D, vitamin E, folic acid and fibre was observed in home-living elderly people, service house residents and nursing home residents (Rissanen, Laakkonen, Suntioinen, Penttilä & Uusitupa 1996, 135-136; Suominen, Muurinen, Routasalo, Soini, Suur-Uski, Peiponen, Finne-Soveri & Pitkälä 2005, 580-581; Vikstedt, Suominen, Joki, Muurinen, Soini & Pitkälä 2011). Because of the prevalence of inadequate intake of these nutrients, they were chose to be studied in this thesis.

The thesis was linked to the EU-project ”Optimised food products for elderly populations” (Optifel) which started in September 2013. The aim of the Optifel-project is to improve the nutrition of the elderly by increasing the knowledge of the nutritional needs of the elderly and the demands and wishes for the food products targeted to them.

The information on nutritional status of Finnish elderly people was collected from Finnish studies and publications. A special attention was paid to the intakes of vitamin D, vitamin E, folic acid and fibre, and their function in nutrition. In addition, nutritious food materials rich in these nutrients were selected for food product development for elderly people. Food materials were selected according to the information on five different food composition databases.

The thesis was commissioned by MTT Agrifood Research Finland together with HAMK University of Applied Sciences.

2 NUTRITIONAL STATUSES OF ELDERLY PEOPLE LIVING IN FINLAND

2.1 Home and service house residents

According to a study (Rissanen et al. 1996, 135-136), the nutritional status of Finnish home-living elderly people (mean age women 79 years and men 78 years) is relatively good. In men, insufficient vitamin and mineral intake was observed and in women also low calorie intake. The mean calorie intake in men was more than 1900 kcal/day and in women a little more than 1400 kcal/day. The intake of vitamin D, vitamin E, folic acid and zinc were below recommendations in men and women, and especially women suffered from vitamin D deficiency.

The nutritional status of elderly people (mean age 83 years) living in service houses in the region of Helsinki was studied by Vikstedt et al. (2011). According to the results, 65 % of the residents were at risk for malnutrition and 21 % suffered from malnutrition. The variability of the intake of energy, protein, and micronutrients was remarkable among the residents. Almost half received less than 1570 kcal/day, and the intake of fibre, vitamin D, vitamin E and folic acid was especially low. The intake of these nutrients was insufficient in 98 %, 98 %, 38 % and 86 % of the elderly, respectively.

2.2 Nursing home residents and long-term care patients

Suominen et al. (2005, 580-581) studied the nutrition of the residents (mean age 82 years) living in nursing homes in Helsinki and factors associated with malnutrition. According to the results, 60 % of the residents were at risk of malnutrition and 29 % suffered from malnutrition. Malnutrition was associated with physical difficulties, such as swallowing problems, constipation and functional impairment, but also with symptoms of dementia and stroke. In addition, eating less than half of the offered food and not consuming snacks were associated with malnutrition.

The nutritional status of 23 residents (age 69 to 89 years) suffering from dementia in a Finnish nursing home was studied, and even 20 residents were at risk of malnutrition, while 3 were malnourished. The intake of energy in the whole group was only 1205 kcal/day and the intake of vitamin D, vitamin E and folic acid was clearly less than recommended. The offered food in the nursing home reached the recommendations in energy and some nutrients, but the problem was that the residents did not eat enough. However, the amounts of vitamin D, vitamin E, folic acid and fibre in the served food did not meet the recommendations. (Suominen 2007, 42)

Nursing home residents (mean age 83 years) who received snacks and whose weight was checked frequently were offered vitamin D supplementation more often than the others. Those who suffered from malnutrition were offered less vitamin D supplementation than those being at risk of

malnutrition or having normal nutritional status. Only 21.2 % received vitamin D in the therapeutic dose of 10 mg or more, and 3.5 % in the recommended dose of 20 mg or more. One fifth received both, vitamin D and calcium supplementation. Those who received vitamin D supplementation had better nutritional status, ate snacks and did not suffer from constipation. (Suominen 2007, 43-44)

Of long-term care patients (mean age 81 years) in long-term care hospitals, 40 % were at risk of malnutrition and 57 % were malnourished. Problems in the nutritional care of these long-term care patients were, for example, non-recognition of malnutrition and not receiving snacks and oral supplements. Nurses recognized malnutrition in only one in four of the actual cases while more than half were malnourished. The patients who suffered from malnutrition received few snacks and oral supplements than those who had a normal nutritional status. (Suominen 2007, 42; 44)

Suominen et al. (2007, 1229-1230) also studied the nutritional status of residents in nursing homes before and after nutrition education of professionals in a nursing home. The impact of the nutrition education was positive. The mean energy, protein and nutrient intake increased, and more residents received the minimum recommended energy intake, while before the education none of the residents did. Before the education none, but after the education 16 % had a good nutritional status, and the professionals felt easier to respond to the nutritional problems and make corrective changes to the residents' diet.

2.3 Hospitalized patients

In Finland, the nutritional status of hospitalized elderly population has not been specifically studied and proper and up-dated reports on this subject were not found. However, in foreign studies some factors associated with malnutrition in hospitalized patients were found.

In a Brazilian study (Oliveira, Fogaca & Leandro-Merhi 2009) the nutritional status and functional capacity of the hospitalized elderly people were studied. Among 240 elderly people 33.8 % were having an adequate nutritional status, while 37.1 % were at risk of malnutrition and 29.1 % were malnourished. Malnutrition was associated with a higher prevalence of need for a caregiver and tube feeding, also with a reduced food consumption, weight loss and functional capacity impairment. A partial or total dependence in eating situations was found in more that 50 % of the malnourished patients and also impairment in other activities of daily living.

An Italian study (Orsitto, Fulvio, Tria, Turi, Venezia & Manca 2009, 101-102) also showed that hospitalized patients with a mild cognitive impairment and dementia suffered more from malnutrition. In the study, the nutritional status of 623 elderly people was studied and 18 % were considered well nourished while the percentages of patients at risk of malnutrition and malnourished were 58 % and 24 %, respectively.

The effect of an individualized nutritional support on weight loss and functional outcomes in hospitalized elderly stroke patients was studied in Norway. The intervention group of the patients received a personal treatment plan for preventing weight loss while the control group received routine care. About 36 % of the control group lost more than 5 % of weight while the percentage in the intervention group was 20.7 %. In addition to preventing weight loss in hospitalized patients, the individualized treatment plan also increased the quality of life and physical strength in the intervention group. (Ha, Hauge, Spenning & Iversen 2010, 269-271.)

3 NUTRTIONAL ASPECTS, RECOMMENDATIONS AND CURRENT INTAKE OF VITAMIN D, VITAMIN E, FOLIC ACID AND FIBER FOR THE ELDERLY

3.1 Nutritional aspects of vitamin D

Vitamin D is a special vitamin since being synthesized in the human skin when exposed to sunlight. Vitamin D has many functional forms but vitamin D_2 and vitamin D_3 are the only forms that can be converted into utilizable vitamin D forms in the human body. Vitamin D_3 is formed from cholesterol and similarly vitamin D_2 is formed from ergosterol in the skin by ultraviolet light. (Lerner & Miodownik 2012, 3.)

Both forms of vitamins are first hydroxylated in the liver to the prohormone 25-hydroxycholecalciferol (calcidiol) and then in the kidney to the vitamin D hormone 1α-25-dihydroxycholecalciferol (calcitriol). Calcitriol has many important functions in the human body, such as acting as an inductor of proteins, promoting calcium resorption in the intestine and an optimal calcium concentration in the kidneys and in the bones. It also has a role in bone health by acting in the synthesis of proteins that are involved in calcification and other bone forming functions. (Belitz, Grosch & Schieberle 2004, 412.)

Vitamin D is a vital nutrient for bone health but also for the function of skeletal muscles. Vitamin D is needed in the absorption of calcium and phosphatase in intestines and therefore helps to maintain the bone health. The deficiency of vitamin D can lead to osteoporosis and muscle loss. These factors in turn may cause downfalls and fractures. (The National Nutrition Council 2009, 43.)

3.1.1 Finnish and Nordic recommendations of vitamin D and the current intake among elderly people in Finland

In Nordic countries the recommended daily intake of vitamin D for the elderly (over 75 years) is 20 µg (Nordic Council of Ministers 2013, 28). To provide a sufficient vitamin D intake in the elderly, the National Nutrition Council (2012, 9) recommends daily vitamin D supplementation of 20 µg for people over 60 years old year round. The safe upper intake level is 50 µg (The National Nutrition Council 2010, 60).

Vitamin D is formed on the skin when exposed to ultraviolet B (UVB) radiation and because of the reduction of daily activities old people are more likely to spend days indoors therefore they are less exposed to the sun light. Furthermore, the production of vitamin D on the skin decreases with age and especially after the age of 70 years so does the intestinal absorption. (Lerner & Miodownik 2012, 144; The National Nutrition Council 2010, 44.)

Changes in the body composition can also affect vitamin D demand. In the aging body the muscle mass decreases and the amount of fat increases. As

being a fat-soluble vitamin, this change in the body composition results in a wider distribution of vitamin D in the body fat and may increase the vitamin demand in older people. (Lerner & Miodownik 2012, 144.)

Aging is not the only reason for the declined vitamin D absorption, also some diseases and medication can affect it. In addition, aging can affect the vitamin D metabolism by decreasing the transformation of functional calcitriol form. (The National Nutrition Council 2010, 43-44.)

According to the national Findiet 2007 Survey (KTL- National Public Health Institute 2008, 66), the intake of vitamin D in elderly men (65-74 years) and women (65-74 years) was 9 µg and 6.5 µg. The intake among both, men and women, was very low and insufficient.

3.1.2 Health effects and deficiency of vitamin D

Studies have shown that vitamin D deficiency among elderly people is common and worldwide. The deficiency can be explained by changes in lifestyle and daily activity but also poor intake from food (Lerner & Miodownik 2012, 144; The National Nutrition council 2010, 43-44).

Vitamin D deficiency causes decreasing of mineral density in bones which appears as osteomalacia. It also increases the level of thyroid hormone in blood which leads to increased bone metabolism that causes osteoporosis. Vitamin D also has an impact on muscle health, and deficiency leads to muscle loss which weakens balance and causes falls. It has been shown that the sufficient vitamin D intake helps to maintain the bone health and coordination and therefore reduces falls and fractures in elderly people. In addition, vitamin D is needed in bone fracture healing and it might have a positive effect on immune system. (The National Nutrition Council 2012, 43.)

The main health effects of vitamin D are linked to muscle and bone health. Falls in the elderly are multi-factorial and muscle weakness has been shown to be an important risk factor for falls. Vitamin D has an important role in muscle function by acting on membrane receptors on myocyte. The deficiency of vitamin D may result in weakness of muscles causing difficulties, for example, in walking up stairs and standing up from a sitting position. However, many studies have attempted to show a correlation between vitamin D supplementation in patients with a deficiency and the effect on muscle strength but the results have been unclear. (Lerner & Miodownik 2012, 145.)

Vitamin D has also other possible health effects. The great interest is its association with cancer but also the immune system, cognitive functions and the relation between cardiovascular diseases and mortality. However, these hypotheses need more comparable studies and results. (Lerner & Miodownik 2012, 146-148.)

It is clear that vitamin D has an important physiological role on muscular function and therefore has an effect on muscle strength, posture and bal-

ance. The correlation with vitamin D deficiency and decreased muscle strength and falls is probably more relevant in the frail elderly and in the studies the amount of vitamin D provided as supplementation might have been insufficient. (Lerner & Miodownik 2012, 145.)

As being a fat-soluble vitamin, overdosing of vitamin D can lead to hypervitaminosis. The wrong dietary supplementation can only lead to hypervitaminosis, food-derived vitamin D cannot cause this. Furthermore, hypervitaminosis and possible poisonings need a long time period of high overdosing of vitamin D and are very rare. (The National Nutrition Council 2010, 44.)

3.2 Nutritional aspects of vitamin E

Vitamin E is a fat-soluble vitamin that is also called tocopherol. There are known at least eight active forms of tocopherols of which α- tocopherol has the highest biological activity and is a nutrient required in human nutrition (Belitz et al. 2004, 413; Herrmann & Obeid 2012, 457; Savolainen 2011). The major role of vitamin E is to function as a chain-breaking antioxidant and prevent, for example lipid oxidation but also stabilize other compounds as hormones and enzymes (Belitz et al. 2004, 413; Herrmann & Obeid 2012, 457). Vitamin E also contributes to the stabilization of membrane structure (Belitz et al. 2004, 413) and eye and heart health (Bauer 2012). However, the specific role of vitamin E in metabolic functions has not been found nor the mechanism of absorption from the intestine (Herrmann & Obeid 2012, 457).

3.2.1 Finnish and Nordic recommendations of vitamin E and the current intake among elderly people in Finland

The daily recommended intake of vitamin E for elderly women (over 75 years) is 8 α-tocopherol equivalents which is 8 mg RRR α-tocopherol and in men (over 75 years) the amount is 10 α-tocopherol equivalents (Nordic Council of Ministers 2013, 28).

The mechanism of absorption of vitamin E is not fully understood yet, but it is known that the same protein facilitates the transfer of vitamin E and cholesterol and hypothetically cholesterol medication may increase the need for vitamin E (Herrmann & Obeid 2012, 259). Generally Finnish people's cholesterol levels have been increasing in the past five years and in elderly population especially those of women. Elderly women's cholesterol levels have been increasing between 2007 and 2012 from 5.5 to 5.6 while the cholesterol levels of elderly men have stayed in 5.0. (Vartiainen, Borodulin, Sundvall, Laatikainen, Peltonen, Harald, Salomaa & Puska 2012, 2365-2367.) The increasing of cholesterol hypothetically increases the usage of cholesterol medication that hypothetically decreases the absorption of vitamin E and therefore the elderly with high cholesterol and cholesterol medication might suffer from an inadequate vitamin E intake.

According to the national Findiet 2007 Survey (KTL- National Public Health Institute 2008, 66), the intake of vitamin E in elderly men (65-74 years) and women (65-74 years) was insufficient with the amount of 8.7 mg and 7.3 mg, respectively.

3.2.2 Health effects and deficiency of vitamin E

Vitamin E deficiency occurs rarely in humans and usually is due to genetic abnormalities (Herrmann & Obeid 2012, 461). However, an insufficient intake of vitamin E in elderly people was observed in Finnish nursing home residents (Suominen 2007, 43). Vitamin E deficiency is associated with neuromuscular problems and hemolytic anemia. As being a fat-soluble vitamin, it can be stored in the body and therefore cause hypervitaminosis. (Bauer 2012.)

The mechanism for vitamin E absorption from the intestine is not fully understood, but the same protein that facilitates cholesterol transfer is also facilitating vitamin E absorption and therefore hypothetically drugs which inhibit cholesterol absorption, will also decrease vitamin E absorption in humans (Herrmann & Obeid 2012, 459).

While the health effects of vitamin E are mainly based on its antioxidative features, the interests in other health effects have been studied. In a Spanish study, the vitamin E supplementation in elderly men and women and its effect on immune functions was studied. In the study, the elderly population was given 200 mg supplementation daily for three months and immune functions were observed. After the supplementation period, it was noticed that a significant improvement of functions of lymphocytes, neutrophils and neutral killer cells was observed. (De La Fuente, Hernanz, Guayerbas, Victor & Arnalich 2007, 275-277.)

Also, in a French study the relation between vitamin E status and the quality of life in the elderly was studied and a clear association was found. Participants with a higher plasma concentration of vitamin E showed lower plasma levels of inflammation and also a better health status and mental and physical quality of life. As associated with both, physical and mental quality of life in the elderly, it is suggested that vitamin E has diverse functions in health and well-being. The regulation of inflammatory process may present the main factor why vitamin E influences the life quality. (Capuron, Moranis, Combe, Cousson-Gélie, Fuchs, De Smedt-Peyrusse, Barberger-Gateau & Layé 2009, 1391-1393.)

On the other hand, some negative influence of vitamin E supplementation has been observed. In a cancer prevention trial, the association of vitamin E supplementation with prostate cancer in healthy men from the United States, Canada and Puerto Rico was studied and surprisingly vitamin E supplementation increased the risk of prostate cancer among healthy men. This demonstrates the potential of seemingly harmless biologically active substances such as vitamins to cause harm. Any risks of vitamin E received from natural food sources were not reported in this study. (Klein, Thompson, Tangen, Crowley, Lucia, Goodman, Minasian, Ford, Parnes,

Gaziano, Karp, Lieber, Walther, Klotx, Parson, Chin, Darke, Lippman, Goodman, Meyskens & Baker 2011, 1551-1553.)

3.3 Nutritional aspects of folate

Folate is a term that refers to a group of water-soluble B-vitamins. Folate has a role as an enzyme cofactor in biosynthetic reactions like synthesis of DNA and regulation of gene expression and is generally found in all forms of life. (Herrmann & Obeid 2012, 95.)

The functioning of folate is known as 1C metabolism which refers to its ability to carry and chemically activate single carbons. Tetrahydrofolate, which is the fully reduced form of the folate, carries single carbons. In the cell, there are five different carbon substituted forms of tetrahydrofolate. (Herrmann & Obeid 2012, 91.) Folate functions as a coenzyme in the metabolism of nucleic and amino acids (Institute of Medicine Staff 2000, 196).

Folic acid is a synthetic, fully oxidized and stable provitamin and is commonly found in dietary supplements and because of its chemical and structural features, folic acid has a higher bioavailability than natural folate (Herrmann & Obeid 2012, 95-96). Bioavailability of food based folate is almost 50 percent lower than the bioavailability of folic acid, which is resulting that 1 µg of food folate is equivalent to 0.6 µg of folic acid from supplements or fortified food (Institute of Medicine Staff 2000, 196).

There is some evidence of folate and vitamin B_{12} working together in metabolism and the deficiency of either vitamins leads to the same kind of haematological changes (Institute of Medicine Staff 2000, 199). Tertahydrofolates are needed in conversion of homocysteine to methionine (Herrmann & Obeid 2012, 91).

3.3.1 Finnish and Nordic recommendations of folate and the current intake among elderly people in Finland

Dietary folate requirements are expressed as Dietary Folate Equivalents (DFEs) to adjust for the increased bioavailability of folic acid compared with natural food folate (Herrmann & Obeid 2012, 95-96). The recommended daily intake of folate is for elderly men and women (over 75 years) 300 µg (Nordic Council of Ministers 2013, 28). Folic acid as a nutrient represents the quality of the diet (Suominen 2013, 49). An inadequate intake of folic acid is associated with diseases, heavy use of medicine products and low income (KTL - National Public Health Institute 2008, 51).

The intake of folate was in elderly men (65-74 years) and women (65-74 years) 243 µg and 210 µg. The intake level in men and women was in sufficient. (KTL- National Public Health Institute 2008, 66.)

3.3.2 Health effects and deficiency of folate

In Finland, folate deficiency is very rare. However, the deficiency can be caused by a poor diet but also by intestinal malabsorption, medication or heavy alcohol use. The deficiency can lead to a type of anemia called megaloblastic anemia in which blood cells are increased in size. It has been studied that an insufficient intake of folate leads to increasing of homocysteine level in serum which is connected to an increased risk of developing a cardiovascular disease. (Parkkinen & Sertti 2008, 124.)

Ho et al. (2011) also reviewed the association of high homocysteine levels with people suffering from Alzheimer's diseases and vascular dementia. A high level of homocysteine and lower levels of folate and vitamin B_{12} were also associated with depression in elderly Greek people. (Dimopoulos, Piperi, Salonicioti, Psarra, Gazi, Papadimitriou, Lea & Kalofoutis 2007, 606-607.)

A significant reduction in homocysteine levels in Italian adults with hyperhomocysteinemia was reached after the supplementation of folic acid. The supplementation was carried out in three different ways: natural folate-rich diet (200 µg/day), 5-methyltetrtahydrofolate supplementation (200 µg/day) and folic acid supplementation (200 µg/day). The effectiveness of all three methods was almost the same by lowering homocysteine levels approximately 20%. The increase of folate intake in the group that followed a folate-rich diet was mainly due to fruits and vegetables and the group that followed the folate-rich diet received almost double times more folate from vegetables and triple from fruits than the other groups. (Zappacosta, Mastroiacovo, Persichilli, Pounis, Ruggeri, Minucci, Carnovale, Andria, Ricci, Scala, Genovese, Turrini, Mistura, Giardina & Iacoviello 2013, 1535-1539.)

The folic acid supplementation was also shown to improve the cognitive function in older adults in the Netherlands. The participants received folic acid supplementation (800 µg) for three years and the effect on cognitive performance was measured. A significant superiority in memory, information processing speed and sensorimotor speed was observed in the intervention group when compared to the placebo group. In addition, the serum folate concentration increased during the supplementation while plasma total homocysteine concentration decreased. (Durga, van Boxtel, Schouten, Kok, Jolles, Katan & Verhoef 2007, 212-214.)

3.4 Nutritional aspect of fibre in nutrition and metabolism

Dietary fibres are carbohydrate polymers that are not digested in the digestive system by acid and enzymes due to their configuration of atomic bonding (van der Kamp, Jones & McCleary 2010, 16; Cho & Prosky 1999, 25). Dietary fibres are divided into two groups: water-soluble and insoluble. Water-soluble fibres are, for example, pectin, beta-glucan, inulin and fructo-oligosaccharides and insoluble fibres are, for example, cellulose, lignin and part of hemicelluloses (Parkkinen & Sertti 2008, 66).

Soluble components of fibre are fermented by the colon bacteria almost completely, unlike the insoluble components of fibre (Cho 1999, 59).

Fibres have many functions in metabolism, but mostly the benefits can be divided into two groups: small intestinal effects and large intestinal effects. In small intestine the main effects of fibre are based on the increased viscosity that delays gastric emptying, digestion and absorption of nutrients into the blood stream. These effects can have consequent effects, such as blood glucose and appetite management. In the colon the entering digesta stimulates the anaerobic bacterial fermentation, so it functions as a prebiotic that increases microbial production of short chain fatty acids which are important for the functioning and differentiation of cells and the expression of gut hormones. (van der Kamp 2010, 153.)

Depending on the unfermented digesta mass and its water-holding capacity, a fibre rich diet increases the faecal mass (van der Kamp 2010, 153) but also softens it (Bauer 2012). This also stimulates peristalsis that pushes the digested mass forward in the gastrointestinal tract and therefore reduces the transit time and prevents constipation (Bauer 2012).

3.4.1 Finnish and Nordic Recommendations of fibre and the current intake among elderly people in Finland

The recommended intake of dietary fiber in a day is 25-35 g (Nordic Council of Ministers 2013, 24). Additional fibre is recommended when an older person is suffering from constipation. Fibre from cereal products reveals constipation better than vegetable based fibre. (National Nutrition Council 2010, 47.)

According to the national Findiet 2007 survey the fibre intake in Finnish elderly men and women was 24 g and 21 g, respectively. In both, men and women, the intake level was too low. However, the fibre percentage of the total energy reached the recommended 3 g/MJ in both, men and women, therefore the main problem of fibre intake is not the fibre content in the eaten food, but the amount of the eaten food. (KTL- National Public Health Institute 2008, 48; 97.)

3.4.2 Health effects and deficiency of fibre

Constipation was associated with malnutrition in Finnish nursing home residents and long term care patients (Suominen 2005, 2007 & 2009). In the national Findiet 2007 survey (KTL-National Public Health Institute 2008, 48) was revealed that the intake of dietary fibre a day in Finnish men and women older than 65 years was 24 g and 21 g respectively, which is below the recommended 25-35 g (Nordic Council of Ministers 2013, 24).

The most important role of fibre in metabolism is to prevent constipation and also slow glucose absorption and therefore it evens out the blood sugar levels (Parkkinen & Sertti 2008, 66; 70). There is also scientific evi-

dence of other health effects of fibre. Fibre-rich plant foods have a positive effect on decreasing the risk of many diseases such as cardiovascular diseases and type-2 diabetes, hypertension and even some forms of cancer such as colorectal cancer. Diets including a lot of fibre-rich plant foods are usually lower in energy density and therefore also help in weight controlling (Nordic Council of Ministers 2013, 19-20; 24). Insoluble dietary fibres, such as cellulose, are effective in the prevention and relieving of constipation. Soluble fibres from berries and fruits are effective in glucose and lipid metabolism (National Nutrition Council 2010, 47).

Constipation is very common among elderly people. Symptoms of constipation are, for example, reduced bowel movement, reduced volume and harder consistency of faeces. Constipation is often treated with laxatives and the use of laxatives also increases with age. (Ratnaike 1999, 187.)

The use of dietary fibre instead of laxative treatment in geriatric patients was studied in Austria with positive results. The addition of oat fibre in the diet decreased the usage of laxatives by 59 %. In the study, the patients having additional fibre in their diet remained constant while the control group that followed the habitual diet lost weight (Sturtzel, Mikulits, Gisinger & Elmadfa 2009, 137). In addition to the treatment of constipation, the use of fibre for the treatment of diarrhoea showed positive effects, such as a significant decrease of the water content of excrement and controlled favourable bowel movement in the Japanese elderly (Nakao, Ogura, Satake, Ito, Iguchi, Takagi & Nabeshima 2002).

In addition to constipation treatment, fibre has also functions in other illness treatment. In a Finnish diabetes prevention study (Lindsrtöm, Peltonen, Eriksson, Louheranta, Fogelholm, Uusitupa & Tuomilehto 2006, 914-915) was shown that increasing of fibre and decreasing of fat and energy in the diet were the best tools not only for long term weight reduction but also overall health and prevention of type 2 diabetes in Finnish, middle-aged and overweight people. A high fibre intake was also associated with a reduced waist circumference, independently of weight change.

The total cholesterol level and LDL-cholesterol level were also studied in healthy Danish adults after having flaxseed fibre supplementation as a form of drink or bread. Flaxseed drink lowered the total cholesterol and LDL-cholesterol by 12 % and 15 %, respectively, while flaxseed bread lowered 7 % and 9 %, respectively, in comparison to the control group. Changes in fecal excretion of fat and energy were also observed. Energy excretion increased when consuming flaxseed drink by 23 % and fat excretion by 55 % in comparison to the control group. No significant differences were noticed in the group consuming flaxseed bread. Interestingly, the same consumption of fibre had different effects on the user whether consumed as drink or bread, which makes the effects of processing and food matrix even more important. (Kristensen, Jensen, Aarestrup, Petersen, Sondergaard, Mikkelsen & Astrup 2012, 2; 4-6.)

The same kind of results were found in a similar study (Thakur, Mitra, Pal & Rousseau 2009) in India, in which people suffering from type 2 diabetes

were consuming a wheat flour product enriched with flaxseed gum daily. In the objective group the blood sugar level, total cholesterol and low-density lipoprotein cholesterol decreased significantly.

Changes in the diet of elderly people and especially decreased intake of fibres were associated with changes in the gut ecosystem. Biagi, Candela, Turroni, Garagnani, Franceschi and Brigidi (2013, 14) reviewed that elderly people with a poor diet had less diverse fecal microbiota.

Jeffery and O'Toole reviewed (2013, 239-240) that resistant starch and oligosaccharides that are undigested in the small intestine, are utilized in the colon by bacteria to produce short chain fatty acids. The level of metabolic activity in the microbiota depends on how much utilizable fibre reaches the gut. The gut microbiota is involved in the production and absorption of vitamins and other micronutrients, and a high concentration of short chain fatty acids may help in the absorption. Also, a high amount of short chain fatty acids may increase the intestinal pH and therefore prevent the growth of potentially pathogenic bacteria, such as *Escherichia coli,* while most of the gut bacteria are tolerant to low pH values.

4 NUTRITIOUS FOOD MATERIALS, RICH IN VITAMIN D, VITAMIN E, FOLIC ACID AND FIBER, AND THEIR SUITABILITY FOR THE DEVELOPMENT OF FOOD PRODUCTS FOR THE ELDERLY

4.1 Food component databases used

Food products rich in vitamin D, vitamin E, folic acid and fibre were searched for from the following food composition databases:

- Fineli - Finnish Food Composition Database (National Institute for Health and Welfare 2013)
- USDA National Nutrient Database for Standard Reference (U.S. Department of Agriculture, 2013)
- NutriData Food Composition Database (Estonian National Institute for Health Development, 2013)
- Danish Food Composition Databank (Department of Nutrition, National Food Institute, Technical University of Denmark, 2008)
- SOUCI-FACHMANN-KRAUT food composition and nutrition tables medpharm online database (Deutschen Forschungsanstalt für Lebensmittelchemie, Freising, 2013)

The contents vary between the sources and are listed in separate columns. First, foods with a high content of the nutrient desired were searched for from the Finnish database and then compared to the other databases. If the desired food was not found in the database, the nutrient content of equal food was chosen or not reported at all. The first criterion for the selected food was the content of desired nutrient. Some foods were chosen because of the common use in the Finnish cuisine and preference of elderly people.

4.1.1 Food sources of vitamin D

Vitamin D is naturally produced on the skin when exposed to the sun light but it can be also obtained from dietary sources. Some dietary sources of vitamin D are shown in Table 1. Fish, especially oily fish, milk products with added vitamin D, margarine and eggs are sources of vitamin D (The National Nutrition Council, 2010, 43). Some wild edible mushrooms, especially genus *Chantarellus* also has a high vitamin D content (Mattila, Piironen, Uusi-Rauva & Koivistoinen 1994). On the other hand, shiitake mushrooms obtained from a supermarket did not contain vitamin D_2 at all. This was probably due to the non-exposure of cultivated mushrooms to sunlight. After a two-hour UV irradiation the vitamin D content in shiitake mushrooms was 22.8 µg. (Jasinghe & Perera 2005, 543-545.) The vitamin D content in wild edible mushrooms may be due to the exposure to sunlight. On the contrary, the absence of vitamin D in cultivated mushrooms is due to the non-exposure to UV-light.

Table 1 The vitamin D content of different foods from different food groups according to the Finnish (Fineli), U.S. (USDA), Estonian (TKA), Danish (DTU - Food) and German (S-F-K) nutrient databases

		Content (µg/100g)				
Food group	Product	Fineli	USDA	TKA	DTU Food	S-F-K
Meat, Fish & Egg	Cod liver oil	-	250	210	250	-
	Eel	25.6	23.3	30	30	20
	Pike perch	24.6	2.5	29	0.7	-
	Whitefish	22.1	12	9.2	3	-
	Baltic herring	17	4.2	19	10.7	7.8
	Salmon	8	10.9	30	30	16
	Egg	1.9	2	2.9	1.75	2.9
	Egg yolk	6.5	5.4	6.5	4	5.6
	Beef	0.5	0.1	0.53	0.6	-
	Pork	0.4	0.2	0.6	0.691	-
	Vension	0.2	-	-	-	-
	Chicken	0.1	-	0.2	0.2	-
Milk products	Milk drinks (added vitamin D)	1	1	0.8-1	0.075-0.1	-
Vegetables & Mushrooms	Chanterelle	12.8	5.3	-	-	2.1
	Morel	4.4	5.1	-	-	3.1
	Milk cap	5.5	-	-	-	-
	Boletus	2.9	-	-	-	3.1
	Champignon	0.2	0.1	0	-	-
Vegetable oils	Margarine 60%	10	0	7	0	2.5

The highest source of vitamin D (Table 1) in the Finnish database was eel with the content of 25.6 µg in 100 g. The other databases supported the vitamin content by presenting approximately similar vitamin content. Pikeperch also had a high vitamin D content in the Finnish and the Estonian databases with vitamin D content of more than 20 µg in 100 g while in the U.S. and the Danish databases the content was only 2.5 µg and 0.7 µg, respectively. The vitamin content of whitefish in the Finnish database was 22.1 µg in 100 g while in the U.S., Estonian and Danish databases the content was only 12 µg, 9.2 µg and 3 µg in 100 g respectively. Baltic herring had the content of 17 µg in the Finnish database and 19 µg in 100 g in the Estonian database. In the Danish database the content was only 10.7 µg in 100 g and less than 10 µg in the U.S. and the German databases. Salmon had the vitamin content of 8 µg, 10.9 µg and 16 µg in 100 g in the Finnish, U.S. and German databases, respectively while the content was 30 µg in 100 g in the Estonian and Danish databases. Egg and egg yolk had content of 1.9 µg and 6.5 µg in 100 g, respectively, and the amount was supported by all the other databases by being approximately the same. Generally raw meat was a very poor source of vitamin D.

The vitamin D content in mushrooms presented in the different sources did not have a clear guideline. The Danish database did not have the vitamin D contents at all for the mushrooms listed in Table 1 and the Estonian database had only the content for champignon. Chanterelle had vitamin D content of 12.8 µg in 100 g in the Finnish database, but the content was only 5.3 µg and 2.1 µg in 100 g in the U.S. and German databases, respectively. The vitamin D content in morel was almost the same in the Finnish, U.S. and German databases by being 4.4 µg, 5.1 µg and 3.1 µg in 100 g, respectively. Vitamin D content in boletus was only given in the Finnish and German databases with the amounts of 2.9 µg and 3.1 µg in 100 g, respectively.

In milk products the amount of added vitamin D in Finland was 1 µg in 100 g and was the same as in the USA. The Estonian database gave the amount of added vitamin D around 0.8 µg to 1µg and the Danish only 0.075 µg to 0.1 µg in 100 g. The German database didn't give the vitamin D content in milk drink products at all. In vegetable oils margarine with 60% of fat had vitamin D content of 10 µg in 100 g. In the Estonian database the amount was 7 µg and in the German 2.5 µg. In the U.S. and Danish databases the content of vitamin D in margarine was 0 µg.

The vitamin D content of different food varied a lot depending on the source database. The foods with equal vitamin D content in three or more databases were cod liver oil, eel, egg and egg yolk. The vitamin D content in fortified milk products in Finland is mostly 1 µg (Maito ja terveys 2011).

4.1.2 Food sources of vitamin E

In Table 2 some nutritious sources of vitamin E are shown. Good sources of vitamin E are especially cereal products and vegetable oils (The National Nutrition Council, 2010).

Table 2 The vitamin E content of different foods from different food groups according to the the Finnish (Fineli), U.S. (USDA), Estonian (TKA), Danish (DTU Food) and German (S-F-K) nutrient databases

		Content (mg/100g)				
Food Group	Product	Fineli	USDA	TKA	DTU Food	S-F-K
Vegetable oils	Wheat germ oil	-	149.4	150	149	174
	Sunflower seed oil	62.2	41.08	63	55	63
	Rapeseed oil	18.9	17.46	18	18.4	23
	Cotton seed oil	17.5	-	-	35.3	38
	Margarine (60%)	12	5	12	13	10
	Olive oil	11.9	14.35	5.1	5.1	12
	Palm oil	6.1	15.94	7.4	15.9	9.5
Nuts & Seeds	Sunflower seed	34.5	35.17	38	49.5	-
	Almond	26.4	25.63	24	24	26
	Hazelnut	15	15.03	-	21	26
	Peanut	10.9	-	12	-	11
Fruits & Berries	Dried apricot	6.2	4.33	-	4	-
	Dried peach	5.6	0.19	-	-	-
	Rose hip	4.1	5.84	4.1	-	4.2
	Sea buckthorn berry	3	-	3	-	3.2
	Cloud berry	3.0	-	3	-	-
	Fig	2.9	0.35	0.1	-	-
	Dried date	2.6	0.05	0.05	-	-
	Black currant	2.2	1	2.2	2.1	1.9
	Avocado peeled	2.1	1.97	3.2	1.3	1.3
	Dried plum	1.8	0.43	0.43	2.3	-
Vegetables & Mushrooms	Bell pepper	2.2	-	2.1	2.9	2.5
Cereal products	Wheat germ	22.1	-	22	11	25
Meat, Fish & Egg	Cod liver oil	-	-	20	30	-
	Eel	8	4	8	8	-
	Egg yolk	5.5	2.58	5.5	5.2	5.7
	Shrimp	4	-	2.9	4	-
	Egg	1.9	1.05	1.9	1.8	2
	Vension	0.8	-	0.76	-	-
	Beef	0.5	0.2	0.36	0.195	-
	Pork	0.4	0.22	0.4	0.1	-

Wheat germ oil had the highest vitamin E content with approximately 150 mg in 100 g and was listed as the best source of vitamin E in the food content databases of the United States Department of Agriculture, National Institute for Health Development of Estonia and National Food Institute of Denmark if not taken into account commercial - and multi vitamin nutritional supplements, but wasn't found in the Finnish database. Other top sources listed were sunflower seed oil with content of approximately 35 mg in 100 g and in the Danish database almost 50 mg in 100 g. Other vegetable oils, such as rapeseed oil had vitamin E content of 18.9 mg in 100 g in the Finnish database and was supported by approximately the same amount in the U.S., Estonian, and Danish databases but in the German database the content was 23 mg in 100 g. Cotton seed oil had the vitamin E content of more than 35 mg in 100 g in the Danish and German databases and in the Finnish 17.5 mg. Olive oil had the content of approximately 12 mg in 100 g in the Finnish, U.S. and German databases while the amount in the Estonian and Danish databases was only 5.1 mg in 100 g. Palm oil had the content of almost 16 mg in 100 g in the U.S. and German databases while the amount in the other three databases was less than 10 mg in 100 g.

Sunflower seed had vitamin E content of approximately 35 mg in 100 g in the Finnish, U.S. and Estonian databases while the Danish database gave a content of 49.5 mg in 100 g. All the databases gave content of 25 g in 100 g for almond. Hazel nut had the content of approximately 15 mg in 100 g in the Finnish and U.S. databases while the content in the Danish and German databases was more than 20 mg. Peanut had content of a bit more than 10 mg in 100 g in the databases of Finland, Estonia and Germany.

Of fruits and berries, the highest vitamin E content was in dried apricot with content of 6.2 mg in the Finnish, 4.33 mg in the U.S. and 4 mg in the Danish databases. On the other hand, dried peach had content of 5.6 mg in 100 g according to the Finnish database while the content in the U.S. database was less than 1mg in 100 g, other databases didn't give information on the vitamin E content in dried peach. In rose hip the vitamin E content was 4.1 mg in 100 g according to the Finnish database and supported by the U.S., Estonian and German databases. Sea buckthorn had content of 3 mg according to the Finnish, Estonian and German databases as had cloud berry. Fresh fig and dried date had content of approximately 3 mg in 100 g in the Finnish database while the amounts in the U.S. and Estonian databases were less than 1 mg for both. Dried plum also had similar values.

Of vegetables only bell pepper had any significant content of vitamin E with 2.2 mg in 100 g in the Finnish database and supported by the Estonian, Danish and German databases. Of cereal products wheat germ had the vitamin E content of more than 20 mg in 100 g except in the Danish databases that gave content of 11 mg.

Cod liver oil had the vitamin E content of 20 mg and 30 mg in 100 g in the Estonian and Danish databases, respectively. The Finnish, U.S. and German databases didn't give information on this. Eel had the vitamin E content of 8 mg in 100 g according to the Finnish, Estonian and Danish data-

bases while the U.S. gave only 4 mg. Egg yolk also had the content of more than 5 mg in all other databases except in the U.S. in which it was less than 3 mg. Generally eggs had the vitamin E content from 1 mg to 2 mg in all databases. Generally meat was a poor source of vitamin E.

Foods that had approximately an equal vitamin E content in different databases in three or more databases were wheat germ oil, sunflower seed oil, rapeseed oil, margarine (60%), sunflower seed, almond, peanut, dried apricot, rose hip, sea buckthorn berry, black currant, bell pepper, wheat germ, eel, egg yolk and egg.

4.1.3 Food sources of folate

In Table 3 is shown that folates can be found in many animal and plant based sources.

Table 3 The folate content of different foods from different food groups according to the Finnish (Fineli), U.S. (USDA), Estonian (TKA), Danish (DTU Food) and German (S-F-K) nutrient databases

		Content (µg/100g)				
Food group	Product	Fineli	USDA	TKA	DTU Food	S-F-K
Meat, Fish & Egg	Liver average	1226	-	110	1000	136
	Kidney average	422.6	-	60	42	93
	Egg yolk	158.9	146	160	51	162
	Egg	51.3	47	69	21	67
Cereal products	Wheat germ	520	281	330	190	520
	Wheat bran	195	79	260	140	195
	Rye crisp	62.8	65	60	110	88
	Mesli average	61.3	400	48	-	-
	Rye bread	60.5	151	27	27	16
Vegetables & Mushrooms	Brown/White bean	394	388	390	140	205
	Chick pea	172	172	66	-	-
	Beetroot	150	-	-	91	83
	Green bean	145	33	57	64	70
	Asparagus	122.5	52	-	150	108
	Cauliflower	85.9	57	47	165	88
	Broccoli	79.1	63	110	239	114
	Pea	59	65	59	25	159
	Leek	56	64	82	82	103
	Zucchini	52	24	44	48	-
	Spinach	48.1	194	190	220	145
Fruits & Berries	Dried papaya	126	-	-	-	-
	Rose hip	52	-	3	-	-
	Kiwi fruit	42	25	42	42	-
	Orange	26.5	34	31	46.2	29
	Fig	14.6	6	3	9	6.7
	Dried apricot	14	10	14	14	5.1
	Banana	12.5	20	14	38	14
	Avocado	11	89	11	93	30
Nuts & Seeds	Peanut	110	240	110	106	169
	Sesame seed	97	97	98	97	-
	Hazel nut	72	113	-	72	71
	Cashew	69.2	25	69	69	-
	Sunflower seed	60	227	-	66	-

In the Finnish database the highest folate content was in liver with the folate content of 1226 µg in 100 g on average. Other good animal based

sources were kidney, egg yolk and eggs generally with the folate content of 422.6 µg, 158.9 µg and 51.3 µg in 100 g, respectively.

Cereal products with a high folate content were especially wheat germ and bran with the folate content of 520 µg and 195 µg in 100 g, rye crisps and rye bread also had a high content with 62.8 µg and 60.5 µg, respectively.

Vegetables with a high folate content were dried beans and chickpeas with the content of 394 µg and 172 µg in 100 g. Beetroot, green beans and asparagus had a high content with 150 µg, 145 µg and 122.5 µg in 100 g, respectively. In addition to the foods listed before, generally green vegetables were good sources of folate, such as broccoli, peas, zucchini and spinach.

In fruits and berries good sources of folate were kiwi fruit, orange, dried apricot and banana. Avocado had a high folate content in the U.S. and Danish databases but not in the Finnish or Estonian databases. Orange also had a higher folate content in the other databases than in the Finnish database and banana in other but the Finnish and Estonian databases.

Nuts and seed with a high folate content were peanuts with the content of approximately 110 µg in 100 g in the Finnish, Estonian and Danish databases while the content in the U.S. and German databases was much higher. Sesame seed and hazel nut had a high folate content in every database while cashews had a high content in every other database than in the U.S. and German databases which didn't show the folate content of cashew at all. Sunflower seed also had a very high folate content in the U.S. database while the content was less than double in the Finnish and Danish databases.

Foods with a reliable content of folic acid that was equal in three or more databases were egg yolk, rye crisp, brown/white bean, asparagus, pea, spinach, kiwi fruit, orange, dried apricot, banana, peanut, sesame seed, hazel nut and cashew.

4.1.4 Food sources of fibre

Some good sources of fibre are shown in Table 4.

Table 4 The fibre content of different foods from different food groups according to the Finnish (Fineli), U.S. (USDA), Estonian (TKA), Danish (DTU Food) and German (S-F-K) nutrient databases

		Content				
Food group	Product	Fineli	USDA	TKA	DTU Food	S-F-K
Cereal products	Rye bran	39	-	-	-	-
	Wheat bran	37.5	42.8	37.5	40.2	45.1
	Crispbread	18.4	16.5	14.9	14.5	14.6
	Oat bran	17.5	15.4	17.5	11.5	-
	Wheat germ	14	13.2	14	12.3	17.7
	Rye flake	13.9	-	13.6	-	-
	Rye bread average	11	5.8	9.4	8.6	6.46
	Oat flake	10	8	10	-	-
	Muesli	8.7	7.3	6.1	-	-
	Bread crumbs	5.3	4.5	-	-	-
Nuts & Seeds	Linseed	26.4	27.3	34.8	18	38.6
	Hazel nut	17.5	9.7	-	8.2	8.22
	Peanut	15.8	9.5	8.1	7.7	11.7
	Sesame seed	12.3	11.8	7.9	18	11.2
	Pecan nut	9.6	9.6	9	9.6	9.46
Vegetables & Mushrooms	Bean average	21.6	15.2	22.3	17.8	23.2
	Parsnip	4.5	4.9	4.5	4.5	2.13
	Asparagus	3.5	2.1	-	1.8	1.27
Fruits & Berries	Coconut flake	16.3	16.3	12.6	12.6	-
	Dried peach	11.6	8.2	2.4	14.3	12.8
	Dried fig	9.8	9.8	18.5	9.3	12.9
	Raisin	9.7	3.7	9.7	3.6	5.2
	Dried plum	8.6	7.1	7	7.6	17.8
	Fig	8	2.9	2.5	2.9	2.02
	Dried apricot	7.3	7.3	7.7	9.3	17.6
	Rose hip	6.1	24.1	10.8	6.1	23.7
	Sea buckthorn berry	6	-	6	-	-
	Black currant	5.8	-	5.8	5.8	6.78
	Avocado	4.8	6.8	3.4	5.2	6.33
	Pear	3.9	3.1	2.8	3.2	3.27

In Table 4 can be seen that the highest fibre content was in dry cereal products. Rye bran had the content of 39 g in 100 g but the amount was only given in the Finnish database. Wheat bran had a content of 37.5 g in 100 g in the Finnish database and followed by the Estonian database. The content in the U.S., Danish and German was more than 40 g. Crisp bread had a content of 18.4 g and 16.5 g in the Finnish and U.S. databases, respectively. While the other databases gave a little less than 15 g in 100 g. Oat bran had a content of more than 15 g in the Finnish, U.S. and Estonian databases but only 11.5 g in the Danish database. Wheat germ had a content of 14 g in the Finnish and Estonian databases, 13.2 g and 12.3 g in the U.S. and Danish databases, respectively, and 17.7 g in the German database. The fibre content of rye bread varied from Finland's 11 g to the USA's 5.8 mg. Oat flake had approximately a content of 10 in the Finnish, U.S. and Estonian databases. Bread crumbs around 5 g in the Finnish and U.S. databases.

Of seeds, linseed had the highest content of fibre in all the databases from Denmark's 18 g to Germany's 38.6 g in 100 g. In the Finnish database, hazel nut had a content of 17.5 g in 100 g while the U.S., Danish and German databases gave less than 10 g. Fibre content in peanut according to the Finnish and German databases was 15.8 g and 11.7 g, respectively, while the amount in the other databases was less than 10 g. Sesame seed had similar information on fibre content of approximately 12 g in the Fin-

nish, U.S. and German databases, while Estonia gives less than 8 g and Denmark even 18 g in 100 g. Pecan nut had almost 10 g in all databases.

Of vegetables only dried beans had a significantly high fibre content from the USA's 15.2 g to Germany's 23.2 g. Parsnip had the content of almost 5g in 100 g except in the German database 2.13 g in 100 g. Asparagus had the content of 3.5 g in the Finnish database but approximately 2 g or less in other databases.

Of fruits, coconut flakes had a content of 16.3 g in 100 g in the Finnish and U.S. databases and 12.6 g in the Estonian and Danish databases. Dried peach had fibre content of 14.3 g in the Danish database while in the Estonian database only 2.4 g. Dried apricot also had a significantly high fibre content in the Danish database with 17.6 g in 100 g while the other databases gave less than 10 g. Dried plum had almost an identical situation. Other dried fruits, such as figs, had a content of approximately 10 g in 100 g in the Finnish, U.S and Danish databases but almost 20 g in the Estonian database and raisins 9.7 g in the Finnish and Estonian databases but less than 4 in the U.S. and Danish databases. Of berries, rose hip had a fibre content of 6.1 g in 100 g in the Finnish and Danish databases, 10.8 g in the Estonian database and almost 25 g in the U.S. and German databases. Sea buckthorn berry had a content of 6g in the Finnish and Estonian databases and black currant 5.8 g in the Finnish database supported by all the other databases with similar results except the U.S. which didn't have information on sea buckthorn berry. Avocado had a fibre content of approximately 5g in the Finnish and Estonian databases, while the U.S. and German databases gave more than 6 g and the Estonian only 3.4 g. Pear had a content of a little more than 3 g in all databases except the Estonian in which it had a little less than 3 g.

The given fibre content of different foods were varying depending on the source database. The most reliable vitamin E values were in wheat bran, crisp bread, oat bran, wheat germ, oat flake, hazel nut, sesame seed, pecan nut, dried fig, dried plum, fig, dried apricot, black currant and pear, of which values were equal in more than three databases.

4.2 Suitable food materials for food product development for the elderly

In the food product development it is important to use nutritious food materials that meet the nutritional needs of elderly people. In addition, it is important to pay attention to food preferences to make the product pleasant for elderly people.

4.2.1 Consumption of different foods of elderly people in Finland

There are differences in the consumption of different foods and food groups between the elderly population (65-74 years) and the working-age population (25-64 years) (KTL- National Public Health Institute 2008, 34-45). The differences in the food consumption may refer to preferences of

specific foods. The food preferences of elderly people should be taken into consideration when developing food products for elderly people.

In Table 5 some food usage percentages are showed and reviewed below it.

Table 5 Proportions of consumers of different food groups and foods among Finnish elderly people (65-74 years) according to the national Findiet 2007 survey (KTL- National Public Health Institute)

Food group / Food	Consumption (%)	
	Men (65-74 years)	Women (65-74 years)
Cereal and bakery products	**100**	**100**
Rye bread	90	91
Mixed flour bread	47	50
Porridge	61	69
Buns and doghnuts	54	53
Vegetables and vegetable dishes	**78**	**93**
Fresh vegetables, vegetable based salads	63	82
Vegetable side dishes	41	50
Fruits, berries, fruit and berry dishes	**88**	**97**
Fruit and berry soups	32	38
Fruit and berry marmalades and jams	31	36
Fruit and berry juices	15	19
Fat spreads, oils, dressings and gravies	**93**	**94**
Margarine (<60%)	48	55
Salad dressings and vegetable oils	18	23
Meat dishes	**98**	**95**
Cold cuts and sausages	69	59
Minced meat dishes	28	24
Meat soups	26	28
Fish dishes	**43**	**50**
Fish, fish fillets	21	21
Egg dishes	**14**	**16**
Milk and dairy products	**97**	**98**
Milks, 0.1-2% fat	45	51
Hard cheeses	50	61
Sour milk	30	28

According to the national Findiet 2007 survey (KTL- National Public Health Institute 2008, 38-39) all the elderly people consumed cereal and bakery products. The most consumed product was rye bread that was consumed by 90 % of men and 91 % of women. Mixed flour bread was consumed by men and women 47 % and 50 %, respectively. Porridge was consumed by 61 % of men and 69 % of women. Buns and doughnuts were consumed by men and women 54 % and 53 %, respectively, and biscuits by 36 % and 38 %, respectively.

Of elderly men (age 65-74 years) and women (age 65-74 years) 78 % and 93 % consumed vegetables, respectively. Of vegetables, the most consumed type of vegetables was in men and women fresh vegetables and vegetable based salads by 63 % and 82 %, respectively. The second consumed type of vegetables was in men and women vegetable side dishes with percentage of 41 % and 50 %, respectively.

The percentage of consumers of fruit and berries in elderly men was 88 % and women 97 %. Of men 58 % and of women 72 % consumed fresh fruits. Berries were consumed by 24 % of men and 41 % of women. Fruit and berry soups were consumed by men and women 32 % and 38 %, respectively, and jams and marmalades by 31 % and 36 %, respectively. Juices were consumed by men and women 15 % and 19 %, respectively.

Fat spreads, oils, dressings and gravies were used by elderly men and women 93 % and 94 %, respectively, while margarine with a fat content lower than 60 % was the most used type by percentage of consumer of 48 % and 55 % of men and women, respectively. Salad dressings and vegetable oils were consumed by men and women 18 % and 23 %, respectively.

Fish dishes were consumed by 43 % and 50 % of men and women, respectively, while fish fillets were the most consumed type of fish. Egg dishes were consumed by 14 % and 16% of men and women, respectively. Meat dishes were consumed by 98 % of elderly men and 95 % of elderly women. Cold cuts and sausages were consumed by more than half of men and women, and minced meat dishes and meat soups by a quarter of men and women.

According to Table 5 97 % of elderly men and 98 % of elderly women consumed milk and dairy products. The most consumed types of the products were milks with a fat content of 0.1-2 % by more than 40 % of men and women. Hard cheeses were consumed by 50 % of men and 61% of women. A little less than a third of men and women consumed sour milk.

4.2.2 Nutritious food materials for product development

In Tables 7-12 food materials are divided into food groups and ranked according to the content of all, vitamin D, vitamin E, folic acid and fibre. The foods are ranked as good, moderate or poor sources of the desired nutrient according to the nutrient content in 100 g. Food is defined as a good source (x) when the content of the desired nutrient in 100 g is 50 % or more of the Nordic nutrition recommendations of daily intake of this nutrient for the elderly. Food is defined as a moderate source (/) when the content of the desired nutrient is from 20 % to 50 % of the recommendation and as a poor source (-) when the content of the desired nutrient is less than 20 % or information on the content does not exist.

The calculated limits according to the nutrition recommendations between the symbols of specific nutrient are shown in Table 5. The nutrient content information of all listed foods in Tables 7-12 is limited to the information on the Finnish food composition database to make Tables 7-12 simple and easier to read and understand.

Table 6 The calculated limits and symbols for definitions of poor, moderate and excellent sources of vitamin D, vitamin E, folic acid and fibre according to the recommended intake of the desired nutrient

	Recommended daily inatake	Less than 20% (-)	From 20% to 50% (/)	More than 50% (x)
Vitamin D	20 µg	< 4 µg	4 µg - 10 µg	>10 µg
Vitamin E	8 mg	< 1.6 mg	1.6 mg - 4 mg	> 4 mg
Folic acid	300 µg	< 60 µg	60 µg - 150 µg	> 150 µg
Fibre	30 g	< 6 g	6 g - 15 g	> 15 g

4.2.3 Nutritious food materials in the food group of meat, fish, egg and milk products

In Table 7 some nutritious food materials are shown from the group of meat, fish, egg and milk products and ranked according to the nutrient content of the selected nutrients.

Table 7 Nutritious food materials from food group of meat, fish, egg and milk products, ranked according to the content of vitamin D, vitamin E, folic acid and fibre in 100 g, explanations for the symbols are shown in Table 6

Food group	Food	Vitamin D (µg/100g)	Vitamin E (mg/100g)	Folic acid (µg/100g)	Fibre (g/100g)
Meat, Fish & Egg	Egg yolk	/	x	x	-
	Eel	x	x	-	-
	Baltic herring	x	/	-	-
	Whitefish	x	/	-	-
	Kidney average	-	-	x	-
	Liver average	-	-	x	-
	Pike perch	x	-	-	-
	Shrimp	-	x	-	-
	Egg	-	/	-	-
	Salmon	/	-	-	-
	Beef	-	-	-	-
	Chicken	-	-	-	-
	Vension	-	-	-	-
	Milk products (D 1µg)	-	-	-	-
	Pork	-	-	-	-

Of all the foods in the group, only egg yolk was a source of all the three vitamins (Table 7). Egg yolk contained 50 % or more of the recommended daily intake of vitamin E and folic acid in 100 g and 20 % or more vitamin D, which made it a god source of vitamin E and folic acid, and a moderate source of vitamin D. Eel was a good source of vitamin D and vitamin E. Baltic herring and whitefish were good sources of vitamin D and moderate sources of vitamin E. Kidney and liver were good sources of folic acid only. Pike perch contained only vitamin D and shrimp vitamin E moderately. Egg contained moderately vitamin E and salmon vitamin D. Beef, chick-

en, vension, milk products and pork did not contain more than 20 % of the recommended daily intake of any of the nutrients.

4.2.4 Nutritious food materials in the food group of vegetable oils

Some foods in the food group of vegetable oils are shown in Table 8 and ranked according to the content of selected nutrients.

Table 8 Nutritious food materials from food group of vegetable oils, ranked according to the content of vitamin D, vitamin E, folic acid and fibre in 100 g, explanations for the symbols are shown in Table 6

Food group	Food	Vitamin D (µg/100g)	Vitamin E (mg/100g)	Folic acid (µg/100g)	Fibre (g/100g)
Vegetable oils	Margarine (60%)	x	x	-	-
	Cotton seed oil	-	x	-	-
	Olive oil	-	x	-	-
	Palm oil	-	x	-	-
	Rapeseed oil	-	x	-	-
	Sunflower seed oil	-	x	-	-

According to Table 8, only margarine was a good source for vitamin D and vitamin E. All the other vegetable oils were only good sources of vitamin E.

4.2.5 Nutritious food materials in the food group of nuts and seeds

Some nutritious foods from the food group of nuts and seed are shown in Table 9 and ranked according to the nutrient content of the selected nutrients.

Table 9 Nutritious food materials from food group of nuts and seeds, ranked according to the content of vitamin D, vitamin E, folic acid and fibre in 100 g, explanations for the symbols are shown in Table 6

Food group	Food	Vitamin D (µg/100g)	Vitamin E (mg/100g)	Folic acid (µg/100g)	Fibre (g/100g)
Nuts & Seeds	Hazel nut	-	x	/	x
	Peanut	-	x	/	x
	Sunflower seed	-	x	/	/
	Almond	-	x	-	/
	Linseed	-	-	/	x
	Sesameseed	-	/	/	/
	Cashew	-	-	/	-
	Pecan nut	-	-	-	/

According to Table 9, of nuts and seeds, hazel nut and peanut were both good sources of vitamin E and fibre and moderate sources of folic acid.

Sunflower seed was a good source of vitamin E and a moderate source of folic acid and fibre. Almond was a good source of vitamin E and moderate source of fibre while linseed was a good source of fibre and a moderate source of folic acid. Sesame seed was a moderate source for vitamin E, folic acid and fibre. Cashew was a moderate source for folic acid and pecan nut a moderate source of fibre.

4.2.6 Nutritious food materials in the food group of fruits and berries

Some nutritious foods from the food group of fruits and berries are shown in Table 10 and ranked according to the nutrient content of selected nutrients.

Table 10 Nutritious food materials from food group of fruits and berries, ranked according to the content of vitamin D, vitamin E, folic acid and fibre in 100 g, explanations for the symbols are shown in Table 6

Food group	Food	Vitamin D (µg/100g)	Vitamin E (mg/100g)	Folic acid (µg/100g)	Fibre (g/100g)
Fruits & Berries	Dried apricot	-	x	-	/
	Dried papaya	-	x	/	-
	Dried peach	-	x	-	/
	Rose hip	-	x	-	/
	Coconut flake	-	-	-	x
	Dried plum	-	/	-	/
	Avocado	-	/	-	/
	Cloud berry	-	/	-	/
	Dried date	-	/	-	/
	Sea buckthorn berry	-	/	-	/
	Black currant	-	/	-	-
	Dried fig	-	-	-	/
	Raisin	-	-	-	/
	Banana	-	-	-	-
	Kiwi fruit	-	-	-	-
	Orange	-	-	-	-
	Pear	-	-	-	-

In Table 10 nutrient sources in the food group of fruits and berries are shown. Dried apricot, papaya and peach were all good sources of vitamin E. Papaya was a moderate source of folic acid while apricot and peach were moderate sources of fibre. Also, rose hip was a good source of vitamin E and a moderate source of fibre. Coconut flake was a good source of fibre. Dried plum, avocado, cloud berry dried date and sea buckthorn berry were all moderate sources of vitamin E and fibre. Black currant was a moderate source of vitamin E while dried fig and raisin were moderate sources of fibre. Banana, kiwi fruit, orange and pear did not contain any of the nutrients more than 20 % of the recommended amount in 100 g.

4.2.7 Nutritious food materials in the food group of cereal products

Nutritious foods from the food group of cereal products are shown in Table 11 and ranked according to the nutrient content of selected nutrients.

Table 11 Nutritious food materials from food group of cereal products, ranked according to the content of vitamin D, vitamin E, folic acid and fibre in 100 g, explanations for the symbols are shown in Table 6

Food group	Food	Vitamin D (µg/100g)	Vitamin E (mg/100g)	Folic acid (µg/100g)	Fibre (g/100g)
Cereal products	Wheat bran	-	/	x	x
	Wheat germ	-	x	x	/
	Rye crisp	-	-	/	x
	Oat bran	-	-	-	x
	Muesli	-	-	/	/
	Rye bread	-	-	/	/
	Rye flake	-	-	/	/
	Oat flake	-	-	-	/
	Bread crumb	-	-	-	-

In Table 11, nutritious food materials from the group of cereal products are shown. According to Table 10, wheat bran was a good source of folic acid and fibre and a moderate source of vitamin E. Wheat germ was a food source of vitamin E and folic acid and a moderate source of fibre. Rye crisp was a good source of fibre and a moderate source of folic acid. Oat bran was only a good source of fibre. Muesli, rye bread and rye flake were all moderate sources for folic acid and fibre. Oat flake was a moderate source of fibre and bread crumbs were not a good or moderate source for any of the nutrients.

4.2.8 Nutritious food materials in the food group of vegetables and mushrooms

In Table 12 some nutritious food materials from the group of vegetables and mushrooms are shown and ranked according to the nutrient content of selected nutrients.

Table 12 Nutritious food materials from food group of vegetables and mushrooms, ranked according to the content of vitamin D, vitamin E, folic acid and fibre in 100 g, explanations for the symbols are shown in Table 6

Food group	Food	Vitamin D (µg/100g)	Vitamin E (mg/100g)	Folic acid (µg/100g)	Fibre (g/100g)
Vegetables & Mushrooms	Chickpea	-	/	x	/
	Brown/white bean	-	-	x	/
	Asparagus	-	-	x	-
	Chanterelle	x	-	-	-
	Spinach	-	-	x	-
	Beetroot	-	-	/	-
	Bell pepper	-	/	-	-
	Boletus	-	-	-	/
	Broccoli	-	-	/	-
	Cauliflower	-	-	/	-
	Champignon	-	/	-	-
	Green bean	-	-	/	-
	Milk cap	/	-	-	-
	Morel	/	-	-	-
	Parsnip	-	-	/	-
	Leek	-	-	-	-
	Pea	-	-	-	-
	Zucchini	-	-	-	-

According to Table 12, chick pea was a good source of folic acid and a moderate source of fibre and vitamin E. Bean was a good source of folic acid too but a moderate source only for fibre. Asparagus was a good source for folic acid while chanterelle was a good source for vitamin D. Spinach was a good source for folic acid while beetroot was only moderate. Bell pepper was a moderate source for vitamin E and boletus for fibre. Broccoli, cauliflower, green bean and parsnip were all moderate sources for folic acid while milk cap and morel were moderate sources for vitamin D. Leek, pea and zucchini were no good or moderate sources for any of the nutrients.

5 CONLCUSIONS

The nutritional status of Finnish elderly people varies significantly. There are many factors that are associated with the poor nutritional status of the elderly. Factors can be physiological changes caused by aging, such as swallowing problems and functional impairment, or cognitive impairment, such as dementia and Alzheimer's disease.

Mostly the problems are patient driven but in some cases the acting of care givers can affect the nutritional status of the elderly. Care giver driven problems are usually a non-recognized poor malnutrition status of an elderly person, or recognition of malnutrition with no actions of improvement. Improvement in the nutrition of elderly people has been achieved through education of care givers and personal diet consulting of elderly people. According to good results of spreading awareness of importance of good nutrition of the elderly and its effect on life quality and healthy aging, educating of the care givers and individual diet planning is recommended.

In most cases the offered food for the elderly reaches the nutritional recommendations fully or at least partly. The problem is not the quality of the offered food, but the amount of the food eaten. If the amount eaten is less than half of the portion, it is likely that the older person is having a poor nutritional status. Even if the offered food reaches the recommendations, lacking of vitamin D, vitamin E, folic acid and fibre has been observed. It is important to offer nutritious snack products and dietary supplementation when the food consuming is low.

Aging also causes changes in the body functioning that may cause an impaired absorption of nutrients and therefore increase the demand for the nutrients. To make sure that the eaten amount requires adequate intake of nutrients, the amount of the eaten food should be increased or the nutrient content of served food should be increased.

The amount of eaten food can be increased by increasing appetite. In food product development for the elderly, the food preferences of the elderly people have to be noticed. In addition, in food product development the effect of processing can be fatal to nutrient content and this should be taken into consideration. Even the food composition can affect the nutrient content of the final product.

Food composition databases are a practical tool for searching for nutritious foods. However, there are significant differences between the databases of different countries and the information in the databases is not always updated. A comparison of different databases is recommended.

According to the Finnish food composition database (National Institute for Health and Welfare 2013) nutritious food materials that were rich in vitamin D, vitamin E, folic acid and fibre or most of these nutrients were nuts, especially hazel nuts and peanuts, dried fruits, dried beans, wheat germ and egg yolk.

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